FIG. 3 shows a version of the invention incorporating a skimmer 16. This consists of an orifice in a hollow conical frustum mounted on conductive wall 15, which is aligned with the axis of tube 5. Wall 15 is mounted on insulators 14, but serves as a barrier between region 7, which is pumped through port 9, and region 18 which is pumped through port 17. With the parameters given earlier, a distance of about 1.5 cm between electrode 6 and the front of skimmer 16 is satisfactory. The diameter of the hole in skimmer 16 is chosen so that the pressure in region 18 can be maintained at about 10^{-5} torr (assuming the pressure in region 7 to be 10^{-3} torr), with an appropriate vacuum pump attached to port 17. If the Invention is used to couple a high pressure ion source to a mass spectrometer, the mass analyser 19 can be situated in region 18 as shown. In the case of a magnetic sector instrument, region 18 will of course be more extensive than shown in the drawing, and may comprise additional pumping stages.

The potentials applied to the various electrodes may conveniently be those described earlier, with wall 15 and skimmer 16 being maintained at potential V_8. Additional electrostatic focussing lenses may be provided on either side of wall 14, and the potential on the skimmer can conveniently be made adjustable so that it can be varied to optimize the transmission of ions into the mass analyser 19. In this case, the entrance aperture of the analyser will be maintained at V_{19}, which will be lower than V_{16}, and the kinetic energy gained by the ions will be equivalant to V_6–V_{19}. V_{19} may conveniently be earth potential, but in some cases it may be found convenient to make it adjustable, especially if analyser 19 is of the quadrupole type.

It will be appreciated that in the apparatus described in FIGS. 1 and 3, many details concerning the construction of the vacuum housings and the mounting of the various components have been omitted. These are standard features of equipment of this kind, and the detailed design of an embodiment of the invention for any particular purpose will present no difficulty to those skilled in the art.

As an example of the use of the invention, FIG. 4 shows a simplified sectional view of the source section of a magnetic sector mass spectrometer coupled by means of the invention to an electrospray type ion source operated with its inlet capillary at earth potential. The solution containing the sample to be ionized is introduced into the electrospray source inlet capillary 21 into chamber 22 which is maintained at substantially atmospheric pressure by means of a flow of nitrogen (optionally heated) through inlet pipe 23 and outlet pipe 24. The walls of chamber 22 are insulated by means of spacer 26 from re-entrant housing 27, and also from inlet capillary 21, so that the capillary 21 can be earthed and the walls of chamber 22 maintained at a high negative potential. A diaphragm electrode 25 is maintained at an intermediate potential in order to improve the effieciency of the ionization process, and end plate of re-entrant housing 27 which carries a conical skimmer 28 is also maintained at an adjustable potential, close to but not necessarily identical with, that on walls 22. The end plate of re-entrant housing 27 may carry heating means 42 to enable insulated tube 29 to be heated. The details of operation of an electrospray ion-source of this type are described in our copending U.S. patent application, Ser. No. 486,645 entitled "Method and Apparatus for The Mass Spectrometric Analysis of Solutions", but it will be appreciated that any known type of electrospray source can be used. Insulated tube 29 is attached to the rear of the exit orifice in skimmer 28 of the high pressure section of the electrospray source, in accordance with the invention, and extends into a region maintained at a pressure of 10^{-3} torr or less in housing 31. A vacuum pump, typically a 1000 l.s.$^{-1}$ diffusion pump, is attached to port 32. The electrospray chamber walls 22 are insulated from housing 31 by an insulated spacer 30. An electrode 33 is attached to the other end of tube 29, as required by the invention. A flange carrying a hollow conical skimmer 34 is insulated from housings 31 and 37 by means of insulating spacer 35, and a conical focussing electrode 36 is provided in housing 31 as required by one version of the invention. Housing 37 is maintained at a lower pressure than housing 31, typically better than 10^{-5} torr, by means of another diffusion pump connected to port 39. A set of focussing lenses 38 are also provided, and the entrance slit 40 of a magnetic sector mass spectrometer, which is preferably of adjustable width, is mounted immediately in front of the flight tube 41 which carries the ions to be mass analysed between the poles of the spectrometer magnet. Alternatively, if a double focussing spectrometer is used, the ions may pass first into an electrostatic analyser after passing through slit 40.

The conditions required to accelerate the ions by means of the invention have previously been described, but in the embodiement shown in FIG. 4, the following potentials are typical, assuming the accelerating voltage of the spectrometer is 8 kV.

V_{21}=0 V (earth)
V_{22}=−6 kV (adjustable)
V_{25}=−3 kV (adjustable)
V_{27},V_{28}=−6 kV
V_{33}=+8 kV
V_{36}=+4 kV (adjustable)
V_{34}=+100 V(adjustable):
V_{38}=that required to optimize transmission
V_{40}=0 V

Thus the potential energy of the ions is increased from about −6 kV to +8 kV as they pass through tube 29, and they are then accelerated to 8 kV kinetic energy between electrode 33 and slit 40 passing through a series of electrodes, the potentials of which can be adjusted to optimize transmission of the ions. If desired at least one of electrodes 38 can be made into a pair of deflector plates between which a small adjustable potential difference is applied in order to deflect the emerging ion beam slightly to compensate for any misalignment of the slits or orifices in the electrodes.

What is claimed is:

1. In a method of increasing the energy of charged particles contained in a gas, the improvement comprising:

(a) maintaining a flow of said gas containing said charged particles from a first region through a tube-like member into a second region where the pressure is maintained substantially lower than in said first region, said flow being great enough to ensure that collisions between molecules of said gas and said charged particles in said tube-like member substantially determine the kinetic energy possessed by said charged particles;

(b) providing along at least part of said tube-like member an electrical potential gradient in a direction which in the absence of said flow of gas would serve to reduce the kinetic energy of said charged particles passing along said tube-like member from